IMPROVED METHOD AND APPARATUS FOR CONTROLLING AUTOMATIC BOWLING PINSETTTERS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to a provisional patent application serial number 60/446,858 titled, "Electronic Lynx," filed February 12, 2003. The entire disclosure of serial number 60/446,858 is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

This invention broadly relates to automatic pinsetters used in the sport of bowling, and deals more particularly with a method and apparatus for improving the operation of certain types of existing pinsetter designs.

BACKGROUND OF THE INVENTION

In the sport of tenpin bowling, a machine known as automatic pinsetter is used to stand tenpins, clear the pins knocked over by the bowler, and return the ball to the bowler. The pinsetter is able to detect several conditions on the bowling lane surface and respond accordingly.

The automatic pinsetter was first conceived in the 1930's, and entered mass production in the early 1950's. These mass produced pinsetters were of two rather different designs respectively manufactured by the AMF Corporation and the Brunswick Corporation. The AMF design relied on electro-mechanical logic for machine control (cams, switches, relays and motors). The Brunswick automatic pinsetter, however, employed completely mechanical logic,

involving a complicated system of cams, levers, belts and cables all driven by a single motor through a gearbox. Newer designs manufactured by Brunswick are similar to the AMF equipment and use essentially all electronic logic and microcomputers in place of the older electro-mechanical systems.

005 Brunswick Corporation produced a series of pinsetters up until about 1985 that were referred to as the Model A or A2 design, and employed completely mechanical logic. Over 100,000 Model A series pin-setters were manufactured by Brunswick, the majority of which are still in operation today. With over 500 moving parts, Model A pinsetters are subject to malfunction due to age, wear, improper adjustment, poor lubrication and other factors. These malfunctions, commonly referred to as a machine "fault", normally require the intervention of a mechanic or on-site technician to clear the fault and return of machine to service. Excessive downtime of the machines naturally reduces customer satisfaction since the bowler's game must be interrupted while the machine fault is being cleared.

006 Many of the faults that occur in Model A series machines are caused by malfunctions in the mechanical control logic used to stop and start various components in the machine. It would be desirable to replace at least portions of this mechanical control logic with electrical controls in order to eliminate faults caused by mechanical malfunctions. The present invention is intended to satisfy this need in the art.

SUMMARY OF THE INVENTION

007 The present invention provides a method and related apparatus for improving the operation of Series A, automatic pinsetters, by replacing a portion of its mechanical logic with electronic controls.

008 According to one aspect of the invention, apparatus is provided for replacing the mechanical start and stop mechanism in an automatic pinsetter. The pinsetter is of the type including a vertically movable deck for setting pins on a lane surface, a turret for loading pins into the deck, a rake for clearing fallen pins from the lane surface, a detector for detecting pins standing on the lane surface, a drive motor, a gear box, a clutch coupling the gearbox with the motor, and a mechanical start-stop mechanism for engaging and disengaging the clutch to start and stop the deck and the rake. The apparatus broadly comprises a set of sensing switches and an electrical controller that is responsive to signals from the switches to control various operations of the pinsetter. The switches includes first, second and third switches respectively generating electrical cycle start, electrical mid-cycle stop, and mid-cycle release signals. The controller is responsive to these signals to: engage the clutch in response to the cycle start signal; disengage the clutch in response to the mid-cycle stop signal; and re-engage the clutch in response to the mid-cycle release signal.

009 According to another aspect of the invention, a method is provided for controlling an automatic bowling pinsetter of the type described above, comprising the steps of: generating an electrical cycle start signal when a first

ball passes into the pinsetter; generating a electrical mid-cycle cycle stop signal when an insufficient number of pins are present in the turret; generating an electrical release signal when a sufficient number of pins are present in the turret; and, controlling the operation of the clutch to start and stop the clutch using the cycle start, mid-cycle cycle stop and release signals.

0010 A primary object of the invention is to provide a method and related apparatus for controlling the operation of automatic pinsetters which eliminates portions of mechanical control logic that are subject to breakage or malfunction.

0011 Another object of the invention is to provide apparatus as described above which can be readily retrofitted to existing pinsetters with minimum modifications to the pinsetter machine.

0012 A further object of the invention is to provide a method and apparatus of the type mentioned above which improves the reliability of Brunswick Model A type pinsetters and reduces the number of machine faults.

0013 A still further object of the invention is to provide apparatus as described above which is capable of automatically clearing an out-of-range condition on the pinsetter, without the need for operator intervention.

0014 Another object of the invention is to provide apparatus of the type mentioned which can manufactured and

supplied as a kit, and easily retrofitted to existing pinsetters.

0015 These, and other further objects and advantages of the present invention will be made clear or will become apparent during the following description of a preferred embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

0016 In the drawings, which form an integral part of the specification and are to be read in conjunction therewith, and in which like reference numerals are employed to designate identical components in the various views:

0017 Fig. 1 is a block diagram showing the major components and sub-systems of a typical Brunswick Model A series automatic pinsetter, according to the prior art;

0018 Fig. 2 is a perspective view of a prior art Model A pinsetter;

0019 Fig. 3 is a perspective view of certain components of the pinsetter shown in Fig. 2, parts being deleted for clarity of illustration;

0020 Fig. 4 is a side elevational view of the gearbox shown in Fig. 3, including related, mechanical control logic;

0021 Fig. 5 is a view similar to Fig. 4, but showing the gearbox having been retrofitted with the control system of the present invention;

0022 Fig. 6 is a fragmentary, perspective view of the clutch stop arm mechanism, depicting the stop arm in its displaced, clutch engaging position;

0023 Fig. 7 is a side elevational view of components forming the pit cushion and rake control mechanism;

0024 Fig. 8 is a fragmentary, perspective view of part of the mechanism shown in Fig. 7, taken on a larger scale, better showing the cycle start switch.

0025 Fig. 9 is a side elevational view of a portion of the detector mechanism showing the mounting for the 180° stop switch;

0026 Fig. 10 is a perspective view of a portion of the turret assembly, showing the mounting for the 180° release switch;

0027 Fig. 11 is an enlarged view of a portion of the turret assembly shown in Fig. 10, better showing the 180° release switch

0028 Fig. 12 is a side elevational view of the detector assembly, showing the mounting location of the out-of-range switch;

0029 Fig. 13 is a combined block and electrical schematic diagram of the control system that forms the preferred embodiment of the invention; and,

0030 Fig. 14 is a combined block and electrical schematic diagram of a control circuit forming part of the control system shown in Fig. 13.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

0031 Referring first to Figs. 1-4, a prior art Model A series A automatic pinsetter is broadly depicted, of the type produced by the Brunswick Corporation. The Brunswick Model A series pinsetter is well known in the art, and the details of its construction and operation are readily available in various technical literature as well as the service manual for such pinsetter offered by the manufacturer and designated the "A-2 Automatic Pinsetter Service Manual." Also, various details of these pinsetters are disclosed in U.S. Patent Nos.3,219,345; 3,810,617; 3,809,398; 3,966,206; 4,813,673 the entire disclosures of which are incorporated by reference herein. Accordingly, for sake of simplicity, a detailed description of all of the parts of the pinsetter will be omitted, and only those components of the pinsetter that are necessary for an understanding of the construction and operation of the present invention will be discussed.

0032 Broadly, the Model A2 pinsetter comprises a vertically movable pin deck 20, a pin turret assembly 26, elevator wheels 28 and a rake 22. The various movable components of the pinsetter are powered by a single electric motor 24 which drives these components through a series of

pulleys, belts gears and shafts. With 10 pins set on the bowling lane surface 25, the ball (not shown) passes through the pins and strikes a pit cushion 27 near the rear of the pinsetter. Entry of the ball into the pinsetter is detected by a ball sensor 46 which may comprise a microswitch attached to the pit cushion 27 that is activated when the ball impacts and displaces the pit cushion 27. Alternatively, the ball may be sensed by an photoelectric device (not shown) which senses passage of the ball using a beam of light.

0033 Disposed at the rear of the pinsetter, the elevator wheels 28 comprise a pair of steel wheels which constantly turn in opposite directions. One of these wheels, known as the ball elevator, lifts the ball and places it onto rails that carry the ball back to the bowler. The other wheel, referred to as the pin elevator, receives fallen pins and carries them upwardly, depositing them in a turn-around pan (not shown). The turn-around pan receives the pins either head first or base first, turns them and deposits them, base first, on a cross-conveyor 32. The cross-conveyor 32 consists in part, of two constantly running parallel belts, (not shown), which carry the pins across the top of the pinsetter and places them one at a time into the turret 26, which in turn stores the pins until it has ten pins and then deposits them into the lane surface 25. The deck 20 lowers and sets the pins on the lane surface 25.

0034 If the bowler does not knock down all the pins with his first ball, the "deadwood" is removed before the second ball is delivered. This operation is accomplished by the deck 20 and the rake 22. The deck 20 lifts the remaining

standing pins up out of the way, the rake 22 sweeps the deadwood into the pit, following which the deck 20 re-spots the standing pins in their original positions. As will be seen later, both the deck 20 and the rake 22 are powered by the motor 24 through a gearbox 36. The gearbox 36 contains a clutch 34 mechanism which stops and starts pinsetter. A detector mechanism 38 is connected to the deck, 20, gear box 36, and rake 22, and essentially the "brains" of the pinsetter. The detector 38 stores knowledge of pinsetter conditions, directs the operation of the pinsetter and handles any of the various situations that are set up by the delivery of the first ball.

0035 As previously indicated, the motor 24 directly drives the turret assembly 26, the elevator wheels 28, cross-conveyor 32, and a pit conveyor belt 30 which conveys both the ball and fallen pins to the rear of the pinsetter. As seen in Fig. 1, motor 24 is coupled by clutch 34 to gearbox 36. Gearbox 36 includes a series of later described output drives which operate the deck 20, rake 22, and the turret 26. The detector 38 couples the deck 20 and the rake 22 with the gearbox 36.

0036 The motor 24 is powered and controlled by an electrical control circuit 100 which broadly comprises an AC power source 40, various transformers and circuit breakers 42, and a time delay module 48. A series of microswitches 44 mounted on various parts of the pinsetter provides input signals to the control circuit 100. A solenoid 50 operates a later discussed clutch control on the gearbox 36 and receives a control signal from time-delay module 48. The ball sensor 46 actuates the time delay module 48 and causes

the latter to delay delivering the clutch control signal to the solenoid 50 for a period of time corresponding to the time necessary to allow the pins to fall and come to rest after the first ball is bowled.

0037 Before explaining further details of the pinsetter and discussing the invention, the various cycles of the pinsetter will be described, and the related sequence of operations will be explained. One complete cycle of the pinsetter is referred to as 360°. The pinsetter is designed to stop at one-quarter (90°), one-half (180°), and a full cycle (360°). The pinsetter is able to respond to a variety of conditions that may be set up by the delivery of the first ball. After the bowler delivers the first ball, the deck 20 lowers toward the lane surface 25 to determine whether the bowler has thrown a strike or whether some pins remain standing. This process is called "detecting" and occurs at one-quarter cycle (90°). Depending on the conditions detected by the deck 20 and detector 38, the pinsetter will continue in its cycle as explained below. In the event that the deck 20 finds no pins remain standing at one-quarter cycle, meaning that the bowler has achieved a strike, the deck 20 raises, and rake 22 sweeps the deadwood into the pit to complete one-half cycle (180°). The deck 20 then lowers again and sets ten new pins onto the lane surface 25 to complete three quarter of the cycle (270°). The deck 20 and the rake 22 rise again, preparing the pinsetter for the next ball, and completing a full 360° cycle.

0038 If, however, the deck 20 lowers and the detector 38 finds some standing pins, the deck 20 grasps the standing

pins and raises them, following which the rake 22 sweeps the deadwood into the pit, thereby completing one-half cycle (180°). The deck 20 then lowers the remaining standing pins onto the lane surface 25, thereby readying the pinsetter for delivery of the second ball. When the second ball is delivered, the deck 20 remains up and the rake 22 sweeps the deadwood. The deck 20 then lowers and sets ten new pins (270°). The deck 20 and rake 22 again rise to prepare the pinsetter for the next ball.

0039 In some cases, the ball may strike a pin in such a way that the pin moves laterally but does not fall. The pin may move far enough to prevent it from being lifted up by the deck 20. To prevent this so called "out-of-range" pin from being swept into the pit, the deck 20 moves down, the detector 38 detects the out of range pin and the pinsetter stops. Before the bowler may bowl again, it is necessary for an attendant to remove the deadwood manually, reset the out-of-range pin, and actuate an out-of-range reset lever (not shown) which restarts the pinsetter. Certain prior art Series A type pinsetters are equipped with automatic out-of-rage detectors which stop the machine when an out-of-range condition is detected.

0040 Referring particularly now to Figs. 3 and 4, a belt 52 coupled with electric motor 24 drives a pulley assembly 54 mounted on the gearbox 36. The pulley assembly 54 is connected to an input worm shaft 56 through the magnetic, friction clutch 34 (Fig. 1) to drive an internal main driveshaft (not shown) within the gearbox 36. The clutch 34 is engaged and disengaged through the movement of a V-shaped clutch yolk assembly 58 which is hinged to an arm of a

clutch lever 60 that is in turn pivoted on the gearbox 36. The yoke assembly 58 comprises a pair of clutch shoes (not shown) which ride in a groove of a clutch drive disk assembly (not shown) inside the gearbox 36. The yoke assembly 58 is connected at its lower regions to an arm of the clutch cam follower lever 98, which in turn is driven by a clutch cam 96.

0041 The main drive shaft within the gearbox 36 is connected through a series of internal gears (not shown) to four external shafts that rotate in various ratios relative to the main drive shaft. These output shafts comprise a 4:1 shaft driving the clutch cam 96, a main gearbox 1:1 shaft driving the cycle cam 94, another 1:1 shaft driving the detector cam 92, and a 2:2 shaft. A complete cycle is equivalent to 1 complete revolution of one of the 1:1 shafts. These varying revolution per pin cycle shafts are required because there are operations which may occur once, twice, or four times during each cycle. The clutch cam 96 can stop the pinsetter four times in one cycle, i.e. at 90°, 180°, 270°, and 360°. The 2:1 shaft drives a deck lowering hook assembly (not shown) which can raise and lower the deck 20 twice in one cycle (once to detect and once to re-spot pins).

0042 Four times in every cycle, as the clutch cam 96 rotates, the lobe on this cam rotates the clutch cam follower lever 98. This movement of the follower lever 98 disengages the clutch at 90°, 180°, and 270° and 360° as desired. A stop arm 62 can be moved under the free end of the clutch lever 60 at 90°, 180° 270° and 360°. When this stop arm 62 is disposed under the end of the clutch lever

60, the clutch 34 will disengage as the lobe of the clutch cam 96 rotates the clutch cam follow lever 98. When the stop arm 62 is not under the clutch lever 60, the clutch 34 is in its engaged state.

0043 As the rising slope of the clutch cam 96 rotates the clutch cam follower lever 98 counterclockwise as viewed in Fig. 4, the lever 98 moves the lower end of the yolk assembly 58 forward. If the stop arm 62 is not under the end of the clutch lever 60, the forward motion of the bottom of the yoke assembly 58 will have no effect, since the top of the yoke assembly will move to the rear, the yoke assembly will pivot on the clutch shoes, and the shoes will continue to ride in the slot in the clutch drive disk assembly (not shown). At this point the clutch is engaged.

0044 If, however, the stop arm 62 is under the clutch lever 60, the top pivot point of the yoke assembly 58 becomes fixed in space as the clockwise motion of the clutch lever 60 is restricted by the stop arm 62. The entire yoke assembly 58 will pivot from its top pivot point as the bottom of the yoke 58 moves forward. At this point, the drive pulley 54 is free to rotate on its bearings without driving the clutch disk drive and internal drive shaft, and the clutch 34 is in a state of disengagement.

0045 The starting and stopping operation of the gearbox 36 is controlled by a triggering mechanism commonly referred to as a start-stop mechanism, consisting primarily of the three levers: a clutch actuator lever 71, a plunger lever 82, and a clutch release lever 84. These three latter mentioned levers are pivoted on a common shaft 73 but are

free to rotate independently of each other. The clutch actuator lever 71 carries the stop arm 62 which can move under the clutch lever 60 to disengage the clutch. A spring 51 on the stop arm 62 urges it clockwise into its stopped position. The plunger lever 82 is pinned at one of its ends to an enclosed slot in clutch actuator link 78 and is connected at its other end to the plunger of a dash-pot (not shown) which absorbs the shock of rotation of the triggering mechanism. The plunger lever 82 is spring-urged in a counterclockwise direction. The clutch release lever 84 carries a pin that rides in an open slot within the clutch actuator link 78. The clutch release lever 84 has a top projection which can contact the stop arm 62 and move it backward, out from under the clutch lever 60, thereby engaging the clutch to start a cycle.

0046 With the clutch 34 disengaged, and the triggering device latched, a spring (not shown) on the plunger lever 82 urges these two levers counterclockwise. At the same time, a reset pin (not shown) in the open slot of the clutch actuator 78 is on top of a clutch latch 72. The levers are prevented from moving counterclockwise and clutch actuator link 78 is prevented from rising by the clutch latch 72 being held by a pin on the clutch reset lever 84. The reset lever 84 is positioned by a cycle cam. The clutch latch 72 is spring urged in a forward, latched direction and is attached through a short connection to a starter, bell crank lever 70.

0047 When a ball strikes the pit cushion 27, the cushion27 pivots slightly to the rear and through a collapsible release mechanism (not shown) lowers the rake 22

to its sweeping position. As the rake 22 lowers, the rotation of the rake lift shaft (described later) mechanically activates the electrical time delay module 48 which starts a timer running to provide sufficient time delay for wobbling pins to fall before the time delay module 48 sends a signal to solenoid 50 (sometimes referred to as the "cycle" solenoid).

0048 The cycle solenoid 50 is mounted on the gearbox 36 directly above the starter bell crank lever 70 and is attached to the lever 70 through a triggering link 68. When the cycle solenoid 50 is energized, the triggering link 68 is pulled forwardly, thus rotating the bell crank lever 70 counterclockwise and, through a short connection, pulls the clutch latch 84.

0049 With the clutch latch 84 withdrawn from under the pin, the plunger lever 82 is urged in a counterclockwise direction, and rotates counterclockwise to force the actuator link 78 upward. The actuator link 78 then comes to a stop, preventing further rotation. A projection on the clutch release lever 84 contacts and rotates the actuator lever stop arm 62, engaging the clutch 34as previously described.

0050 The time delay described above is utilized during the first ball cycle only. On the second ball cycle, the deck 20 does not lower to detect pin fall, therefore the time delay 48 module does not delay operation of the solenoid 50. The time lapse between ball impact and sweeping by the rake 22 is adequate to allow wobbly pins to fall. The pinsetter is stopped and then restarted using two

different methods. At the end of a strike cycle or standing pin cycle, the pinsetter is required to stop at 0° with the clutch latch 72 under the reset lever pin and all levers in position so it requires ball impact to engage the clutch 34.

0051 However, at 180°, the pinsetter may have to stop if the deck 20 does not have 10 pins to deliver to the lane surface 25 and then restart without ball impact after the deck 20 receives 10 pins. This requires a special 180° stop mechanism which is mounted on the gearbox 36 but only partially shown in Fig. 4. In addition, further mechanism is provided to disengage the clutch when an out-of-range pin condition exists. This mechanism, only partially shown in Fig. 4, includes an out-of-range stop lever mounted on shaft 73 which is controlled by linkage (not shown) connected with and driven by the detector 38.

0052 From the foregoing, it is clear that the "start and stop mechanism" carried on the gearbox 36 which controls operation of the clutch 34 is a relatively complicated mechanism formed from links, pins, cams and shafts. This mechanism can fail or malfunction for any of a wide variety of reasons, producing a machine fault.

0053 Reference is now made to Fig. 5 which shows the control system of the present invention, and also depicts the gearbox 36 with numerous parts of the previously described start and stop mechanism having been removed.

0054 The parts which have been removed are replaced by the present control system, include the following major items: cycle solenoid 50; starter bell crank lever 70; pin

detector link 80; turret interlock link 76; reset lever 74; clutch latch 72; clutch actuator link 78; short link connection (not shown); plunger lever 82; springs, 88,90; and strike cam link 112. In accordance with the present invention, this latter mentioned list of parts, including related pins and biasing springs, are replaced by an electronic controller mounted on gearbox 36, along with three later discussed sensing switches.

0055 Referring now concurrently to Figs. 5 - 14, the control system of the present invention includes a control module 120 which is secured to the gearbox 36 by mounting plate 122 and suitable fasteners. The module 120 includes a control circuit contained within a protective housing 104. The details of the control circuit are shown in Figs. 13 and 14. The circuit includes a pair of later discussed solenoids 146, 148 having reciprocal plungers (not shown) that are respectively connected with control links 114, 116. As best seen in Fig. 5, the lower end of control link 114 is coupled by a pivotal connection to one end 83 of the bell crank shaped clutch release lever 84. The other end 85 of the clutch release lever 84 normally bears on the clutch actuator lever 71. Spring 77 connected to a projection 75 on one end of lever 71 normally biases lever 71, and thus stop arm projection 62, to rotate in a clockwise direction. One end of the clutch lever 60 is bifurcated to receive the projection 62, and includes a roller 70 which contacts and rolls along an edge of the stop arm 62.

0056 When the clutch 34 is in its disengaged state, stop arm 62 is disposed beneath the roller 79, maintaining the clutch lever 60 in its raised, disengaged position. To

engage the clutch 43, solenoid 146 pulls control link 114 upwardly, causing the clutch release lever 84 to rotate counter-clockwise. This counter-clockwise movement results in the end 85 of he clutch lever 84 displacing the clutch actuator lever 71 counter-clockwise, overcoming the biasing force of the spring 77 and moving the stop arm 62 away from beneath the roller 79. As the stop arm 62 moves away (toward the left as viewed in Fig. 6), roller 79 moves down along the edge of lever 71, displacing the clutch lever 60 to engage the clutch 34. When the clutch cam 96 (Fig. 5) is actuated to disengage the clutch 34, clutch lever 60 moves upwardly (as viewed in Fig. 6), and the spring 77 causes the actuator lever 71 to rotate clockwise, in turn causing the stop arm 62 to move back into blocking relationship beneath the roller 79.

0057 The lower end of control link 116 (Figs. 5 and 9) is connected by a pivot pin to an out-of-range, reset control arm 118 which forms part of the detector 38. Movement of control link 116 results in resetting the pinsetter after the detection of an out-of- range condition. The control circuit contained within the module housing 104 is connected to various parts of the pinsetter through a series of electrical contacts contained within connectors 134, 136 and 138. Connector 134 connects the control module 120 with sensing switches 106, 108, 110 as well as the time delay module 48. Connector 136 couples the control module 120 with a 115 volt AC power source. Finally, connector 138 couples with the control module 120 with the out-of-range switch 140.

0058 The control module 120 includes three status lights, 128, 130, 132 whose function will become later apparent. Additionally, a pair of momentary push-type switches, 124, 126 are provided. Switch 124 functions as an on-off switch for the entire control system, while switch 126 initiates, upon depression, a machine cycle.

0059 Referring particularly to Fig. 13, a 115 AC power source is coupled via connector 136 through a fuse 152 to pins 1 and 3 of a control circuit 150, the details of which are shown in Fig. 14. The solenoids 146, 148 are powered by the 115 volt AC source, and controlled by the control circuit 150.

0060 In addition to the connections previously described, connector 134 couples a 24 volt AC source with the control module 150, as shown in the lower left-hand corner of Fig. 13. A 24 volt relay 142 controls switch contacts 144 which, when closed, connect 115 volts across solenoid 146. As previously described, the plunger (not shown) of solenoid 146 is coupled with control link 114, to control operation of the clutch lever 60. Switches 106, 108, 110, 140 as well as time delay relay 48 are each coupled with and form inputs to the control circuit 150.

0061 Referring now particularly to Fig. 14, 24 volt DC power coupled across pins 4 and 5 of control circuit 150 is rectified by a rectifier 154, clamped by a clamping circuit 156 and filtered by a capacitor 158. The resulting DC voltage is regulated by a linear regulator 160 so as to provide a regulated, 5 volt DC input to a microcontroller 162. Microcontroller 162 may comprise, for example, a PIC

12F629P microcontroller circuit such as that available from Microcircuits, Inc. Although not specifically shown, microcontroller 162 includes a microprocessor, suitable memory and associated control architecture to function as a microcomputer for controlling operations of the control module 150. As previously mentioned, the control module 150 receives a number of input signals. These signals are input to the microcontroller 162 as follows. A 180° stop signal produced by switch 106 is delivered to pin 4 of the microcontroller 162. A 180° release signal produced by switch 106 is delivered to pin 3 of the microcontroller 162, and an out-of-range signal generated by the switch 140 is input to pin 2 of the microcontroller 162. Microcontroller 162 is responsive to these various signals indicative of machine conditions to control the operation of relays 164, 166 via a corresponding pair of switching transistors 168, 170. Relay 164 is operative to close relay contacts 170 which couples the 115 volt AC source across solenoid 146. Similarly, relay coil 166 closes relay contacts 172, coupling 115 volts across solenoid 148.

0062 In operation, to initialize the control system, on-off switch 124 is moved to its actuated, on position, thereby coupling 24 volts to the control circuit. At this point, before a bowler bowls the first ball, switches 106, 108 and 110 are in the respective positions shown in Fig 13. Additionally, the contacts of the time-delay relay 48 are open. When the bowler bowls the first ball, the ball enters the pinsetter and strikes and displacing pit cushion 27 at the rear of the pinsetter. This displacement results in moving switch 106 to its closed position, thereby delivering 24 volts to the contacts of the time-delay relay 48. The

time delay relay 48 is also actuated by displacement of the pit cushion 27, or in those cases where a photoelectric ball detector is used, the time-delay relay 48 is actuated by a signal produced by the ball sensor 46.

0063 In any event, the contacts of the time-delay relay 48 close after a few seconds, allowing the pins to fall and come to rest. Closure of the time-delay relay 48 couples 24 volts across relay 142, resulting in the closure of relay contacts 144. Upon closure of contacts 144, 115 volts is coupled across solenoid 146, causing link 114 to move upwardly, in turn causing the stop arm 62 to move out from beneath the clutch lever 60. With stop arm 62 having been so displaced, clutch arm 60 moves downwardly, thereby engaging the clutch via the yoke assembly 58. With the clutch engaged, a machine cycle is commenced where the rake 20 initially moves downwardly toward the lane surface 25 and stops while the deck 20 moves down to detect and grasp any pins that remain standing. As the rake 22 moves downwardly, switch 106 is moved back to an open position, thereby applying 24 volts on pin 5 of the control circuit 150. At the same time, movement of switch 106 to an open position removes power from relay 142, causing contacts 144 to open, thereby removing power from solenoid 146.

0064 Microcontroller 162 is programmed to delay a brief period, e.g. 2 seconds after it receives power via pin 5 of the control circuit 150 and then outputs a signal to transistor 168 which switches power to relay 164. Relay 164 closes relay contacts 170 thereby connecting a circuit between pins 1 and 3 of the control circuit 150. With pins 1 and 3 so connected, 115 volts is maintained across

solenoid 146 in spite of the fact that contacts 144 have been open as a result of relay 142 having been de-energized. With solenoid 146 remaining in its actuated state, the clutch 34 remains engaged and the pinsetter continues through its cycle. Solenoid 146 remains energized until switch 106 is switched back to its normally closed position as a result of the rake 22 returning to its raised, rest position at the end of the cycle. It should be noted here that the time delay feature of the microcontroller 162 described above could be adapted to eliminate the need for the time delay module 48, if desired.

0065 At one quarter cycle, if the detector 38 detects an out-of-range condition, switch 140 is closed thereby connecting pins 8 and 9 of the control circuit 150. The control circuit 150 responds to the out-of-range input signal by turning on switching transistor 170 which energizes relay 166. With relay 166 energized, relay contacts 172 are switched closed, thereby connecting a circuit between pins 1 and 2 of the control circuit 150. With pins 1 and 2 of control circuit 150 closed, 115 volts is coupled across the solenoid 148. When solenoid 148 is energized, its plunger moves link 116 toward the left as viewed in Fig. 5, which in turn displaces the out-of-range reset lever 116. The control circuit 150 pulls solenoid 148 to its powered state for only a brief interval, e.g. 4 seconds. After this brief interval, control circuit 150 de-energizes relay 166, thereby de-powering solenoid 148, allowing the out-of-range reset lever 116 to shift back to its normal position. The clutch 34 remains engaged throughout this sequence of events, resulting in the deck moving back up to its raised position, following which the

rake raises, readying the pinsetter for the next ball. In the event that there are fallen pins remaining on the lane surface 25 that may interfere with the next ball, an attendant must be called to clear these fallen pins. Otherwise, however, the automatic out-of-range feature of the preset invention eliminates, in many cases, the need for intervention by an attendant.

0066 Assuming that an out-of-range condition does not exist, the rake 22 sweeps deadwood to the rear of the pinsetter and returns to its forward, lowered position in preparation for the deck 20 setting the remaining standing pins, or in the case of a strike, setting ten pins. In the event that ten pins have not yet been loaded into the turret assembly 26, switch 110 is switched from its normally opened to its normally closed position, thereby connecting pins 7 and 8 of the control circuit 150. Control circuit 150 responds to the input signal on pin 7 by de-powering relay 164 which in turns removes power from solenoid 146, causing the gear box clutch 34 to disengage.

0067 The clutch 34 remains disengaged while the pinsetter continues to load pins into the turret assembly 26. When the turret assembly 26 is fully loaded with pins, switch 108 closes, coupling pins 6 and 8 of the control circuit 150. The signal on pin 6 is interpreted by the control circuit 150 as a command to reengage the clutch 34 in order to continue the cycle. Consequently, the microcontroller 162 energizes relay 164, causing power to be reapplied to solenoid 146 which in turn reengages the clutch 34.

0068 Fig. 7 shows the relationship between the pit cushion and the rake control mechanism which controls the operation of the rake 22. Impact of the ball with the cushion 27 causes the latter to pivot. This pivotal motion displaces connecting rods 212 and 214, causing a mechanism (not shown to release crank arm 216. Partial rotation of crank arm 216 allows rake lift rod 210 to move downwardly, in turn lowering the rake 22. Referring also now to Fig. 8, the crank arm 216 is secured to and rotates with a rotatable rake lift shaft 206. A rake sweep arm 208 connects the rake 22 with a rake sweep shaft 202. The switch 106 is secured by a mounting bracket 200 to a stationary center brace rod 204. An actuator clip 208 secured on the lift shaft 206 is aligned with a trip lever 210 on the switch 106, so as to normally engage and hold down trip lever 210. When the ball strikes the pit cushion 27 causing the rake 22 to drop, the shaft 206 rotates, resulting in the clip moving off the trip lever 210 to actuate switch 106. This actuation of switch 106 sends a cycle start signal to the control circuit 150 to start a machine cycle. The cycle start switch 106, in combination with other parts of the control system, effectively replaces the reset lever, clutch latch, starter bell crank, clutch actuator link and short link of the previously described stop-start mechanism.

0069 Fig. 9 shows the mounting position of the 180° stop switch 110. Stop switch 110 is mounted of the side of a support plate 115 which forms part of the detector 38. Switch 100 includes a spring loaded actuating button 113 which is disposed in the path of movement of a detector timing pin 111 carried on a cam follower 113. Cam follower 113 includes a roller 222 which engages and follows detector

timing cam 127. In the event that 10 pins have not been delivered to the turret 26, cam 127 displaces follower 220, causing pin 11 to actuate the 180° stop switch 110. The 180° stop switch along with certain other components of the control system, effectively replace the pin detector link of the previously described, prior art start-stop mechanism.

0070 Figs. 10 and 11 shows the details of the 180° release switch 108. Switch 108 is secured on a bracket 123 which forms part of the turret frame 117. A rotatable cross shaft 119 passes through openings in the rear of the frame 117. The cross shaft 119 includes a pin 121 passing through one of its ends. The 180° release switch 108 is mounted on the bracket 123 and includes a trip lever 125 aligned so as to be contacted and displaced by the pin 121 upon rotation of the shaft 119. The 180° release switch 108, in combination with other components of the inventive control system, effectively replaces the plunger lever, 180° turret interlock link, clutch release lever, and spot-stop caller of the previously described, prior art start-stop mechanism.

0071 Fig. 12 shows the mounting details for the out-of-range switch 140. Switch 140 is secured to one side of a plate 143 forming part of the detector 38. A bell-crank out-of-range lever 118 is mounted on plate 143 and has an upper end 145 positioned to contact a trip lever 141 of switch 140. When an out-of-range condition is detected, bell crank lever 118 is driven to rotate clockwise by an out-of-range selector cam (not shown), causing the upper end 145 to close the switch 140. As previously described, closure of switch 140 results in solenoid 126 pulling the out-of-range reset lever 116 toward the left as viewed in

Fig. 12, thereby resetting the pinsetter in preparation for the next bowled ball. Lever 116 is pivotally connected to the upper end of a rake sweep hook cam follower lever 147 which pivots about shaft 149. The follower lever 147 includes a follower roller that rides on a rake sweep hook cam (not shown). A link 155 (Figs. 7 and 12) and is pivotally connected to the upper end of follower lever 147, while a control ink 157 is pivotally connected at the lower end of the lever 147. The link 155 is connected to the rake control mechanism shown in Fig. 7, and the control link 157 is connected to a deck holding hook (not shown) which controls movement of the deck 20.

0072 When the reset lever 116 is pulled to the left (Fig. 12) by the solenoid 126, link 155 shifts to the left, and control link 157 shifts to the right. This shifting of link 155 causes rake 36 to rise. Shifting of the control link 157 causes the deck holding hook (not shown) to capture certain mechanism on the deck which holds the deck in its raised position until after the next ball is bowled.

0073 The preferred embodiments, aspects, and features of the invention having been described, it will be apparent to those skilled in the art that numerous variations, modifications, and substitutions may be made without departing from the spirit of the invention as disclosed and further claimed below.